

WHAT IS CLAIMED IS:

1. An ultrasonic transducer comprising:

a first outer-electrode group and a second outer-electrode group, in which the piezoelectric elements and the internal electrodes are alternately layered respectively, and that are connected to the corresponding internal electrodes,

wherein upon alternating voltage being applied to the first outer-electrode group and/or the second outer-electrode group simultaneously, a primary resonant mode and a secondary resonant mode are excited to generate ultrasonic elliptical vibration; and

conducting films for connecting outer electrodes, formed so as to be in contact with the surface of the ultrasonic transducer, for electrically connecting predetermined outer electrodes in the first outer-electrode group to predetermined outer electrodes in the second outer-electrode group.

2. The ultrasonic transducer according to Claim 1, wherein a hole in which a supporting member or a member for transmitting a driving force can be mounted is formed substantially at a node common to the primary resonant mode and the secondary resonant mode.

3. The ultrasonic transducer according to Claim 1, further comprising lead wires or a flexible substrate having electrodes, which is electrically connected to the conducting films for connecting outer electrodes.

4. The ultrasonic transducer according to Claim 1, wherein the piezoelectric elements are formed of lead-zirconate-titanate piezoelectric ceramics.

5. The ultrasonic transducer according to Claim 1, wherein the internal electrodes are formed of an alloy of silver and palladium, silver, nickel, platinum, or gold.

6. The ultrasonic transducer according to Claim 1, wherein the outer electrodes and the conducting films for connecting outer electrodes are formed of silver, an alloy of silver and palladium, or platinum.

7. The ultrasonic transducer according to Claim 1, further comprising frictional members bonded to positions where the ultrasonic elliptical vibration is generated.

8. The ultrasonic transducer according to Claim 1, wherein the primary resonant mode is longitudinal resonance

and the secondary resonant mode is flexural resonance.

9. The ultrasonic transducer according to Claim 8, wherein a hole in which a supporting member or a member for transmitting a driving force can be mounted is formed substantially at a node common to the primary resonant mode and the secondary resonant mode.

10. The ultrasonic transducer according to Claim 8, further comprising lead wires or a flexible substrate having electrodes, which is electrically connected to the conducting films for connecting outer electrodes.

11. The ultrasonic transducer according to Claim 8, wherein the piezoelectric elements are formed of lead-zirconate-titanate piezoelectric ceramics.

12. The ultrasonic transducer according to Claim 8, wherein the internal electrodes are formed of an alloy of silver and palladium, silver, nickel, platinum, or gold.

13. The ultrasonic transducer according to Claim 8, wherein the outer electrodes and the conducting films for connecting outer electrodes are formed of silver, an alloy of silver and palladium, or platinum.

14. The ultrasonic transducer according to Claim 8, further comprising frictional members bonded to positions where the ultrasonic elliptical vibration is generated.

15. An ultrasonic transducer comprising:

outer electrodes, in which the piezoelectric elements and the internal electrodes being alternately layered, and each being connected to the corresponding internal electrodes;

a first layered part including at least the internal electrodes, each being divided in half in a second direction orthogonal to a layering direction, which is a first direction;

a second layered part including at least the internal electrodes, each being divided in half in the second direction;

a first outer-electrode group provided so as to be connected to predetermined internal electrodes respectively in the first layered part;

a second outer-electrode group provided so as to be connected to predetermined internal electrodes respectively in the second layered part; and

conducting films for connecting outer electrodes, formed closely contacting with the surface of the ultrasonic

transducer, so as to electrically connect predetermined outer electrodes in the first outer-electrode group to predetermined outer electrodes in the second outer-electrode group,

wherein upon alternating voltage being applied to the first outer-electrode group and/or the second outer-electrode group simultaneously, and a primary longitudinal resonant mode in the first direction and a secondary flexural resonant mode in a third direction orthogonal to the first direction and the second direction being excited, ultrasonic elliptical vibration is generated in the ultrasonic transducer.

16. An ultrasonic transducer comprising:

outer electrodes, in which the piezoelectric elements and the internal electrodes being alternately layered, and each being connected to the corresponding internal electrodes;

a first layered part including at least the internal electrodes, each being divided in half in a second direction orthogonal to a layering direction, which is a first direction;

a second layered part including at least the internal electrodes, each being divided in half in the second direction;

a first outer-electrode group provided so as to be connected to predetermined internal electrodes in the first layered part;

a second outer-electrode group provided so as to be connected to predetermined internal electrodes in the second layered part; and

conducting films for connecting outer electrodes, formed closely contacting with the surface of the ultrasonic transducer, so as to electrically connect predetermined outer electrodes in the first outer-electrode group to predetermined outer electrodes in the second outer-electrode group,

wherein upon alternating voltage being applied to the first outer-electrode group and/or the second outer-electrode group simultaneously, and a primary longitudinal resonant mode in a third direction orthogonal to the first direction and the second direction and a secondary flexural resonant mode in the first direction being excited, ultrasonic elliptical vibration is generated in the ultrasonic transducer.

17. An ultrasonic transducer comprising:

outer electrodes, in which the piezoelectric elements and the internal electrodes being alternately layered, and each being connected to the corresponding internal

electrodes;

an internal-electrode group, in which the piezoelectric elements and the internal electrodes being alternately layered, and each internal electrode in the internal-electrode group being substantially quadrisected in a second direction and a third direction, which are orthogonal to a layering direction, which is a first direction;

a first outer-electrode group and a second outer-electrode group, each being connected to the internal-electrode group; and

conducting films for connecting outer electrodes, formed closely contacting with the surface of the ultrasonic transducer, so as to electrically connect predetermined outer electrodes in the first outer-electrode group to predetermined outer electrodes in the second outer-electrode group,

wherein upon alternating voltage being applied to the first outer-electrode group and/or the second outer-electrode group simultaneously, and a primary longitudinal resonant mode in the second direction and a secondary flexural resonant mode in the third direction being excited, ultrasonic elliptical vibration is generated in the ultrasonic transducer.

18. An ultrasonic motor comprising at least:

the ultrasonic transducer according to Claim 1;
a driven body that moves with respect to the ultrasonic transducer; and
a pressing member for pressing the ultrasonic transducer toward the driven body.

19. An ultrasonic motor according to Claim 18, wherein the driven body moves straight.

20. An ultrasonic motor according to Claim 18, wherein the driven body rotates.